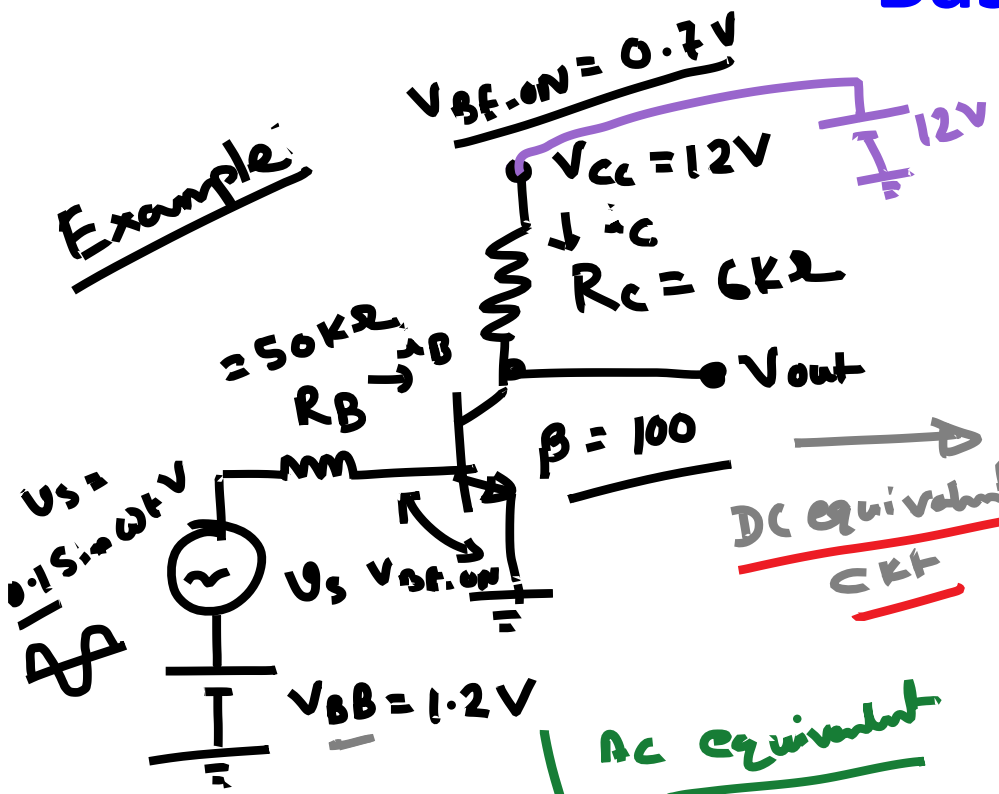
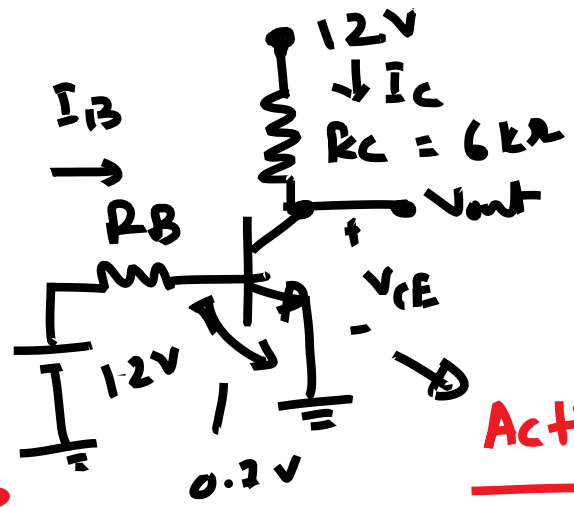
Basic BJT Amplifiers



DC equivalent ckt



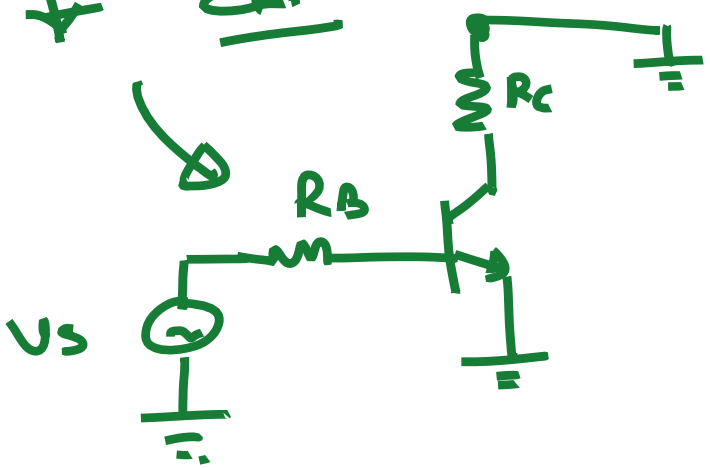
Active region

$$I_{B_Q} = \frac{1.2 - 0.7}{50k\Omega} = 10\mu A \quad ; \quad I_{C_Q} = \beta I_{B_Q} = 1\ mA$$

$$V_{CE_Q} = 12 - I_{C_Q} \times R_C = 6\ V > V_{CE_{sat}}$$

Element	DC	AC
R	R	R
C	open	X_C Short
L	Short	X_L open
V_s (indep)	V_s	Short
I_s (")	I_s	open

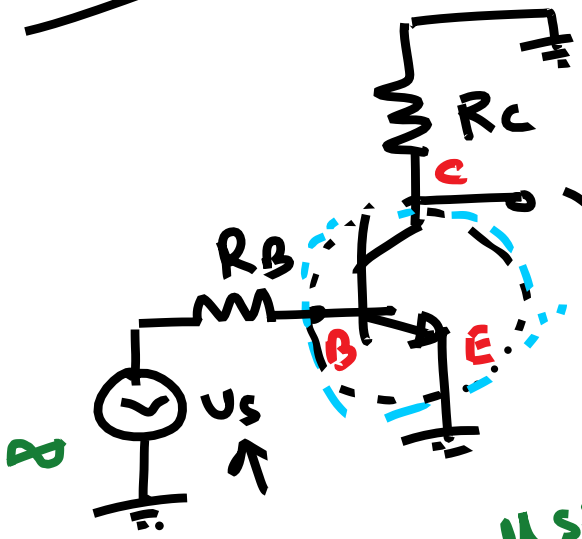
AC equivalent ckt

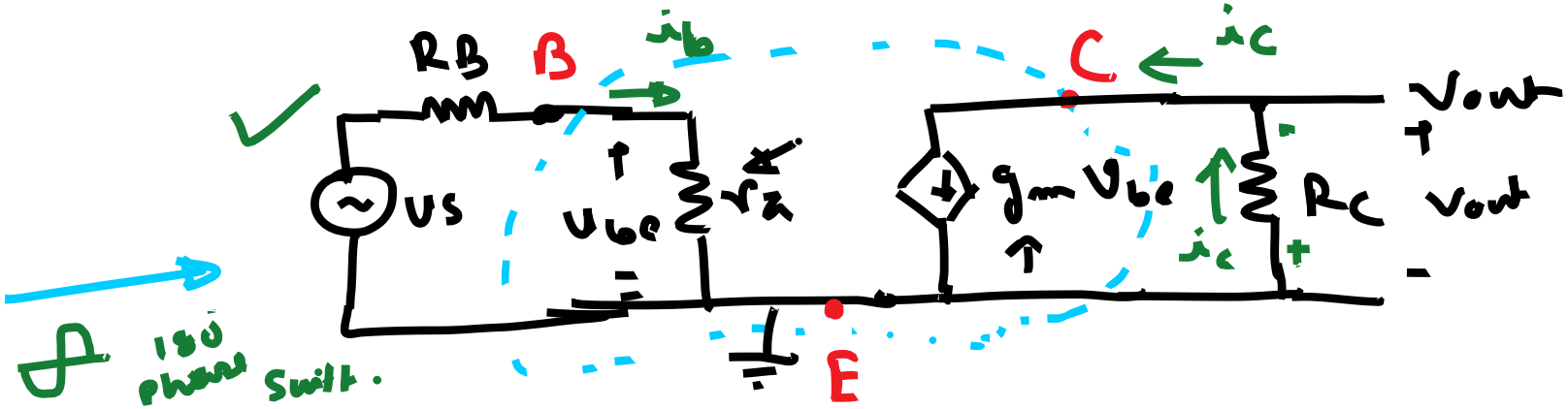


Basic BJT Amplifiers

Waveforms: i_B, i_C, $V_{out} = V_{CE}$

AC equivalent ckt





180° phase shift.

$$r_\pi = \frac{\beta V_T}{I_{CQ}} = \frac{100 \times 0.026}{1\ mA} = 2.6\ k\Omega$$

$$g_m = \frac{I_{CQ}}{V_T} = \frac{1 \times 10^{-3}}{0.026} = 38.5\ mA/V$$

Find gain: (Small signal)

$$\text{gain} = \frac{V_{out}}{V_s}$$

$$V_{out} = -i_c R_c = -g_m V_{be} \cdot R_c = -g_m R_c \cdot \frac{r_\pi}{R_B + r_\pi} \cdot V_s$$

$$V_{be} = \frac{r_\pi}{R_B + r_\pi} \times V_s$$

$$\text{gain} = \frac{V_{out}}{V_s} = -g_m R_c \frac{r_\pi}{R_B + r_\pi}$$

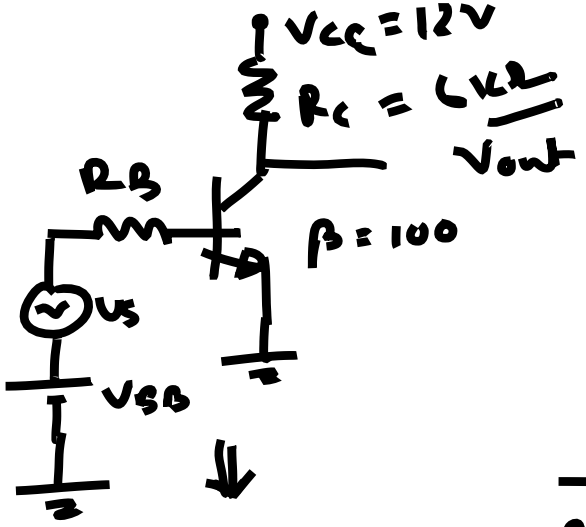
$$\text{gain} = -(38.5 \times 10^{-3}) \times 6 \times 10^3 \times \frac{2.6}{50 + 2.6} = -11.4$$

Basic BJT Amplifiers

$V_s = 0.1 \sin \omega t$ V

$V_s = 0.1 \sin 314000t$

$\omega = 2\pi f = 314000 \Rightarrow f = \frac{314000}{2 \times 3.14} = \frac{10^5}{2} = 5 \times 10^4$ Hz

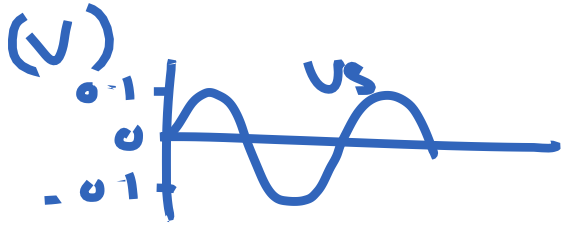


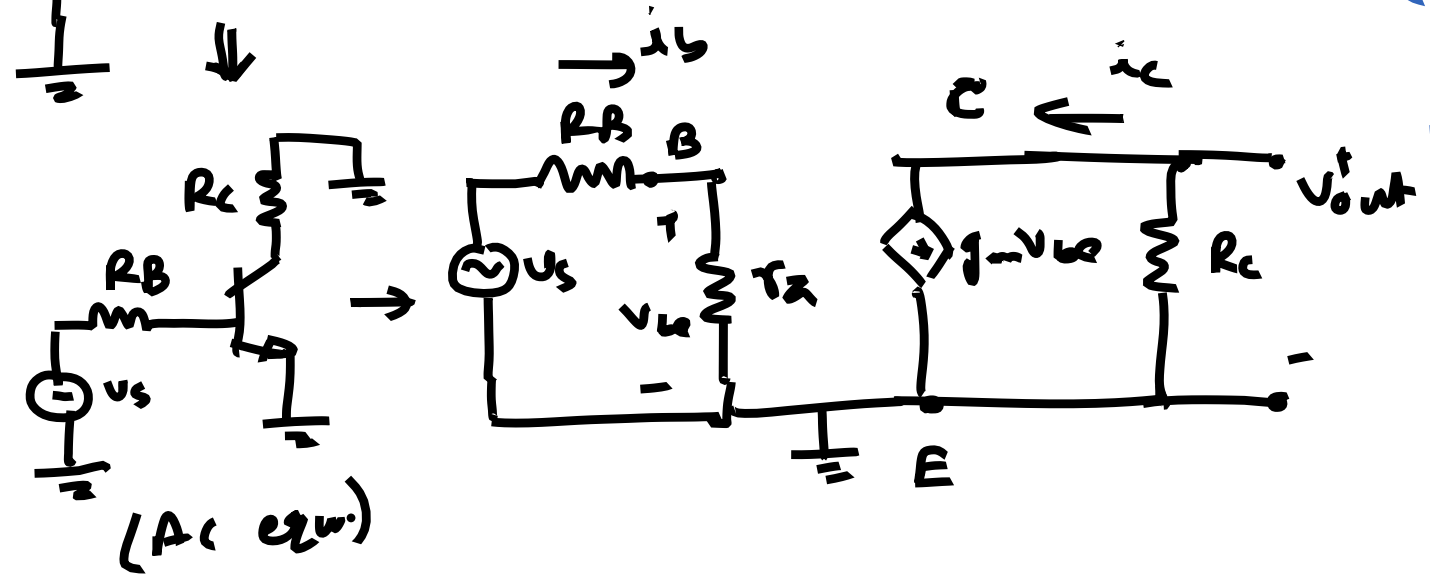
$i_b = \frac{V_s}{R_B + r_\pi} = \frac{0.1 \sin \omega t}{(50 + 2.6)\,k} = 1.90 \sin \omega t$ μA

i_b, i_c

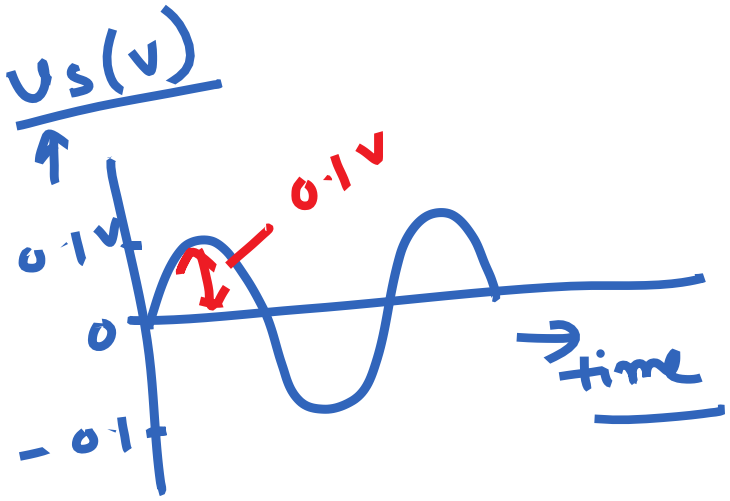
$i_c = \beta i_b = 0.19 \sin \omega t$ mA

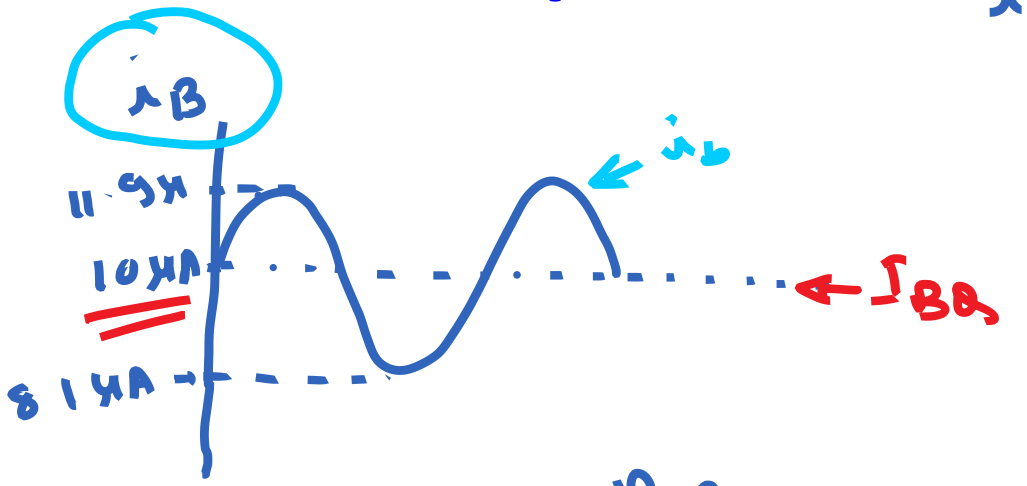
$V_{ce} = V_{out} = -i_c R_c = -(0.19 \sin \omega t) \times 6 = -1.14 \sin \omega t$





Basic BJT Amplifiers





$i_B = I_{BQ} + i_b \rightarrow 1.9\sin\omega t\ \mu A$

$I_{BQ} \rightarrow 10\mu A$